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A REVIEW OF THE BIOLOGY AND DISTRIBUTION OF THE HOURGLASS SPIDER(1)

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Recent discussion of the hourglass or "black-widow" spider (**Latrodectus mactans** Fabr.) has directed much attention to it, with special reference to the venom and its physiological effects on man and laboratory animals. Some authors have discussed its general biology, including ecological facts, and a few mention exact locality records. The beginnings of the present paper consisted of field observations and collections of hourglass spiders made by the writer and his students during the year 1934(2). Many valuable comments and reports from correspondents have been added to these records, and the available literature has been reviewed.

COMMON NAMES: The most acceptable common name for **Latrodectus mactans** is "hourglass spider", although the species has also acquired the name of "shoe button" spider. The female is widely known as the "black widow" spider, although some Californians are beginning to call her the "poison lady." As stated by Philip (1935), it is due to the habit of eating its mate that the female owes the name of black widow.

DESCRIPTION: The bright brick-red "hourglass" of **Latrodectus mactans** is situated on the under surface of

(1). Contribution from the Department of Biology, Southwestern College, Winfield, Kansas.

(2). I wish to express my appreciation to Dr. Roger C. Smith of Kansas State College for his co-operation, criticism, and enthusiastic encouragement; to my research and field assistant Mr. Cornelius R. Rogers for his excellent service; to Dr. R. H. Painter for his criticism of the manuscript; and to the following for distributional records and other favors: Dr. M. H. Swenk, University of Nebraska; Dr. John Breukelman, Kansas State Teachers College of Emporia; Dr. Alexander Wetmore, U. S. National Museum; Dr. George F. Knowlton, Utah State Agri. College; Prof. L. D. Wooster of Fort Hays Kansas State College. I am also indebted to S. C. Bishop, Elmer P. Cheatum, Harold J. Cook, Fred E. D'Amour, E. O. Deere, N. O. Eaddy, J. R. Eyer, Howard M. Field, Mr. and Mrs. A. A. Heinze, Theodore Just, Moody J. R. Lentz, A. W. Lindquist, Albert Milzer, Felix Nolte, Cornelius B. Philip, H. C. Severin, Percy Viosca, and Ralph Voris. To all of these I am deeply grateful.

the abdomen in both sexes. Otherwise the body is deep brown to coal black, with or without irregular, reddish or yellowish markings middorsally. The variation in the details of arrangement of the red markings appears to be independent of locality. A progressive developmental metamorphosis in color pattern leads to a marked secondary sexual dimorphism. The young spiderlings are light in color. During the first days of life they gradually take on a darker pigmentation, becoming coal black with red, pink, or pinkish yellow middorsal and midventral abdominal patches. In older individuals the amount of light color on the abdomen becomes more or less restricted but the adult males almost always retain a coloration closer to that of the half-grown females of corresponding size. In large individuals, the red becomes a little more intense or brighter as its area is reduced. The red may disappear dorsally and sometimes it is divided into more than one spot ventrally. On the basis of rather limited comparisons, the hourglass marking of large females appears to be more prominent in examples from wooded districts, such as those of eastern Louisiana. Some ledge-inhabiting Kansas specimens have only a small dot of red on the ventral side and Baerg (1929) found the hourglass markings entirely unrepresented in two individuals from Durango, Mexico. The fully adult females are over an inch long (counting the legs, which are about as long as the body) while the adult males are approximately one-half the size of the females.

EFFECTS OF THE BITE: Much has been published on the effects of the hourglass spider venom. Baerg (1923, p. 547) has shown that the male is relatively timid and that it does not bite as readily as the "black widow." Whether or not the male can or will inflict a really dangerous bite upon man seems to be an open question. Brazil and Vellard (1926) stated that the venom is neurotoxic. By far the most comprehensive treatment of this phase of the subject appears in the work of Bogen (1926 and 1932), who has presented a combined bibliography and summary of 632 references. Nearly 400 instances of poisoning from the bite of the hourglass spider have been reported. Unnecessary operations (such as appendectomy) could be avoided if all physicians recognized that an acute condition with rigidity of the abdomen, fever, leucocytosis, and occasionally nausea and vomiting, may result from the bite. This

arachnidism may be differentiated from acute abdominal disorders requiring surgical intervention by the presence of spasm in muscles other than those of the abdomen, by the absence of marked abdominal tenderness, and by the concomitant rise in the pressure of the blood and spinal fluid. The mortality rate is low and patients usually recover spontaneously within a few days, but the suffering is intense and several more than a dozen fatalities have been reported. Dr. N. O. Eaddy has drawn attention to the seriousness of the bite ((1934) but he has stated (letter, Jan. 22, 1935) that he believes that the venom is never fatal to man when the victim has not been previously in ill health. Walsh and Morgan (1933) reviewed 29 cases of the spider bite, stating that the symptoms tend to vary in different patients. Accurate case histories are important, for among the various afflictions that may be mimicked are those of ruptured gastric ulcer, strangulated hernia, ruptured appendix, pneumonia, and tetanus. Baerg (1926 and 1929) has given an interesting and thoroughly scientific account of his rather serious personal experience with the bite of this spider, as well as details of his experiments on poisoning white rats. The bite produces appreciable symptoms in rats, which do not necessarily lead to fatal results. After repeated tests, rats showed lessened effects from the administration of the venom, so an acquired immunity is built up. Becker and D'Amour (1934) have recently prepared a potent anti-serum against the venom. In dealing with human cases, Bogen (1932) indicated that specific treatment with serum from convalescent victims is of value, particularly if administered early.

The prevention of spider bite depends upon popular education as to the danger of these spiders and the advisability of their eradication whenever possible. It appears that many slight wounds of unknown origin, and even some insect bites or stings, may be attributed to this spider. When there is a known bite, the wound should be treated with a reliable antiseptic, such as strong tincture of iodine or mercurochrome of the medical solution that is sufficiently potent to "sting" when placed upon open wounds. Pain is relieved by the application of heat from hot water, so hot baths are given after the poison has spread through the body. Baerg (1923, p. 543) has found that the effect of the venom is the same in the winter as it is in the summer.

LIFE HISTORY: Berg (1923, p. 536) has found that the young are born to cannibalism, and that in a jar where 1200 to 1500 spiderlings hatched, only two were left after five weeks. Lawson (1923) stated that the young spiders themselves seem to be the best food in the first few days of life, and pointed out that because of the remarkable sexual dimorphism in the size of the species, practically all of the survivors in an enclosed colony will be females, for the small size of the male is an evident handicap in his fierce preliminary struggle for existence. The egg laying occurs between midnight and morning, during which time the egg case is spun upon anchoring silken attachments, eggs are thrust into one end, and the cocoon is sealed shut. It takes about two hours to accomplish this. Each egg case holds from 220 to 917 eggs, which are said to hatch in 10 days (Baerg, 1923, Arkansas) or in 15 to 28 days (Lawson, 1933, Kansas). Illingworth (1931) stated that in Hawaii the female forms an egg case each week and that after one mating as many as 15 cases have been made by a single female in captivity. Maturity is reached, in Hawaii, in from one to two months in the case of the female, but in more northerly regions, the full two months or even longer is required. There are 8 or 9 molts during development. The males, as indicated by Baerg, mature less slowly than the females, and they are rather difficult to rear. The males are relatively scarce in the early summer, although some can usually be found at all times. The males become comparatively more abundant as the season progresses. This may be due to the fact that many old females die at the end of the summer.

The male and the female are very frequently seen together in the late summer and autumn. Immediately after the habitat is exposed, the timorous male makes desperate attempts to escape. Sometimes this activity diverts attention from the less agile female, thus offering her a degree of protection, but it is usually a case of leaving the female to her own resources.

WEBS: The web is both a home for the hourglass spider and a trap for its victims. The webs have been found in numerous situations, the most dangerous from the standpoint of man being across the openings in out door toilets. In fact records show that well over half of the primary punctures in cases of human spider poisoning are made in the region of the genitalia. On Septem-

ber 16, 1934, Mr. Milzer counted 29 black widow spider webs in corners around the Mercantile Bank and Trust Company Building in the heart of Boulder, Colorado. He counted 49 more webs within the range of an additional block. He also discovered 21 webs in corners on the right side and 32 webs on the left side of a bridge a short distance away. Illingworth (1931) found that in Hawaii the young are dispersed by the wind blowing them along with their thin light ballooning threads; sometimes they even go out to sea.

HIBERNATION: Hourglass spiders of both sexes may overwinter as adults. On December 28, 1934, Mr. Milzer dug out several dozen hibernating, mature females in sand banks in the south part of Denver, together with several immature males, and great numbers of spiderlings. Three days later, on December 31, Mr. Cornelius R. Rogers turned over an old hog trough at Lake City, Kansas, and secured an adult male, which showed signs of life almost immediately. Dr. Elmer P. Cheatum has written from Dallas (letter, Jan. 9, 1935) as follows: "Although the species has been collected during the coldest part of the year in Dallas County, I have yet to see an example in a complete state of torpidity. About December 26 I collected two females under one old log. When I placed them in a bottle they proceeded at once to spin a web, and after that a battle was waged and one appeared to be materially weakened by the encounter. I conclude from this little incident that the females may fight among themselves." Jellison and Philip (1935) found Montana specimens hibernating (during November and December, 1932) in old nests of the Columbian ground squirrel (**Citellus columbianus**) at a point below the frost line.

CAPTURE OF PREY: Lawson (1933) reported that the young fed on a large variety of small insects, including Hemiptera and fruit flies. During August 1934, Mr. Cornelius R. Rogers made a field observation on a large "black widow" in the act of subduing an adult grasshopper (**Melanoplus differentialis** Thom.). The spider sprang from an improvised web upon the unsuspecting insect, sinking its chelicerae into the metathoracic region of the grasshopper. Feeble movements of the jumping legs and antennae were the only signs of life after the poison had been injected. The spider proceeded to weave a web about the immobile body, and started to suck nourishment from its victim.

HABITAT: The hourglass spider occurs very commonly under rocks in the limestone ledges of the east-central part of Kansas. In the more wooded belts where rocks are not available (such as those of sections of eastern Arkansas and Louisiana), the creatures are found in or under rotting logs, under bark, in weeds, in woodpiles, in brush, or even about pieces of tin, cement, bricks, cardboards, or other protecting debris. Moderately dry conditions are readily tolerated, and various individuals live about wood or stone in sandhill districts where semi-arid conditions prevail. Dr. J. R. Eyer of State College, New Mexico, states that a few specimens can always be found around human dwellings, but that they may also be exceedingly numerous on desert mesas many miles from human habitations. Dr. Fred E. D'Amour has collected specimens in Denver in brickyards, in sand banks along streets and near the Platte River, and about rubbish heaps in vacant lots, as well as inside of basements, garages, and dwellings. Both D'Amour (letter) and Lawson (1933) mention the hourglass spider as a regular inhabitant of clumps of prairie cactus plants.

Jellison and Philip (1935) have recently called attention to **Latrodectus mactans** as an inhabitant of the burrows of the Columbian ground squirrel. The spiders stretch their webs across the openings of these burrows, especially of those that are deserted. When disturbed, the spiders retreat backward along the walls of the tunnels. This habitat is no doubt favorable in regard to furnishing a food supply, for it holds a rather plentiful and constant insect fauna. Jellison and Philip also observed many hourglass spiders in the semi-arid, unirrigated bench lands of the Yakima Valley in Washington, where webs and spiders were found in the openings of abandoned warrens of cottontail rabbits. Dr. George F. Knowlton has recorded specimens in Utah from basements, barns, sheds and outdoor toilets. Professor L. D. Wooster located an individual in a watermelon in Kansas and stated that a boy shook one out of the leg of his pants. Baerg (1929) wrote that in Arkansas the black widow is most commonly found under stones and similar retreats wherever the ground is moderately dry. During a dry season, the spiders often find shelter in dry stream beds, in the housings of water meters, and in the basements of houses.

ABUNDANCE: There seems to have been an un-

questioned increase in the number of hourglass spiders in the western half of the United States, and in the Southeast during the past few years. However, Dr. S. C. Bishop (letter, Jan. 7, 1935) does not believe that it has spread greatly or is any more abundant than usual in the Northeast. Dr. Theodore Just and Dr. Marcus Lyon of Notre Dame University, state that their only local report was not verified by a specialist. Dr. Howard M. Field of Madison, Wisconsin, and Professor H. C. Severin from Brookings, South Dakota, reported negative findings. Dr. Cornelius B. Philip has recorded (letter) negative results for 1934 from the eastern half of the Dakotas and from Minnesota. Professor Myron H. Swenk stated that prior to the droughty season of 1934, **Latrodectus mactans** had been found only a few times in Nebraska, but it has manifested an unprecedented increase in abundance during the past season. Mr. Harold J. Cook of Gering also enthusiastically supported this conclusion.

The hourglass spider has been present in Kansas at least since 1904 (Scheffer), but it has definitely become more abundant in recent years with the peak having been reached in the season just past. During the summer of 1934 over 100 specimens were collected by Cornelius R. Rogers within an area of not more than a square mile surrounding the town of Lake City, Kansas. Individuals were even taken from the hard, crusted cattle tracks which were found in the dried stream beds of this drought stricken area. Numerous specimens were found in piles of driftwood, last year's bird nests, feed shocks, and even under scattered debris at the edge of wheat fields. All of these habitats were unusually dry and covered with dust. Eighteen of the spiders were found along the window casings just inside of the screens of the High School building at Lake City. Conditions appear to be the same in Colorado as in Kansas and Nebraska. Dr. Fred E. D'Amour took about 600 specimens within the city limits of Denver in 1934, and 200 in Daniels Park south of Denver. Mr. Albert Milzer secured numerous hibernating examples of various sizes in Denver on December 28, 1934, and on the basis of this and other observations, predicts an even greater population of **Lactrodectus mactans** in Colorado during the year 1935.

A phenomenal increase in the occurrence of **Latrodectus mactans** is evident in the Hawaiian Islands in recent years. Here the pineapple areas are probably

most infested, especially where mulching paper is used (Illingworth, 1931).

Professor J. R. Eyer of State College, New Mexico. is the only one to indicate to me a probable decrease in the hourglass spider population in 1934, stating that "During the eight years that I have been in New Mexico, I would say that this arachnid was particularly abundant in the region of the State College during the years 1928 and 1929 and that it has been slightly on the decrease ever since. Two years of extremely dry weather have severely reduced insect life in our part of New Mexico except in the irrigated valleys, and I presume that the hourglass spider would be similarly affected."

MIGRATION TO THE CITY: Becker and D'Amour (1934) have called attention to the fact, as many observers agree, that the hourglass spider is not only increasing in numbers in the West, but it is also changing its habits. Where formerly it was reported very largely from rural communities, with the seat of the outdoor latrine as the classic location for its web, it is now invading the cities.

ALTITUDE DISTRIBUTION: Herms (1926) reported the occurrence of the hourglass spider in considerable numbers in the Coachella Valley of southern California bordering on the famous Salton Sea at an average altitude of about 125 feet below sea level. Elsewhere, **Latrodectus mactans** has become abundant at points varying from barely above sea level (as in New Orleans) to 10,000 feet (Estes Park, Colorado).

GEOGRAPHICAL DISTRIBUTION: The spider occurs over most of the United States, but it is by far the most abundant in the Southwest and the West. Bogen (1932) listed and analyzed 380 cases of spider poisoning from 18 states, with 17 deaths reported. He added 9 states to the list from which **Latrodectus mactans** had been identified, but in which no cases had been recorded. These 27 states may be listed alphabetically as follows: Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Nevada, New Hampshire, New Mexico, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia and West Virginia. None of these states is adjacent to Canada.

Philip (1935) has given a significant summary of his study of the northern distribution of the spider during the past few years. To the above list of 27 states he adds the following eight: Idaho, Maine, Michigan, Montana, North Dakota, South Dakota, Washington, and Wyoming. Reports for Nebraska were included by Worley and Pickwell (1927), so **Latrodectus mactans** has been reported from at least 36 of the United States to date.

According to Philip (1935), Canadian records are available for the provinces of Alberta, British Columbia, Manitoba and Ontario, all of which border the United States on the north. The range of **Latrodectus mactans** extends to the southward on the mainland at least as far as Peru in South America, and the species has also been reported from the West Indies.

The following exact locality records have been obtained from field observations, correspondents, and the literature(1).

ARIZONA (All records from U. S. Nat. Mus. specimens): COCONINO (Bright Angel, Schwarz and Barber, July 10, 1901); GILA (Miami, Luce, 1927); PIMA (Tucson, Hubbard); and YAVAPAI (Prescott, Ewing, Apr. 5, 1927) counties.

ARKANSAS: CLAY (Piggott, Lentz); DALLAS (6 mi. N. Fordyce, Burt, June 5, 1934); and NEVADA (5 mi. S. Prescott, Burt, June 24, 1934) counties.

CALIFORNIA: LOS ANGELES (Los Angeles, Bogen); RIVERSIDE (Coachella Valley, Herms) counties.

(1). The following collectors and correspondents have furnished records listed here: Joe Ackley, Mrs. Sibyl Adams, George S. Atwood, H. S. Barber, John Breukelman, C. E. Burt, Elmer P. Cheatum, R. P. Colmer, Harold J. Cook, Fred E. D'Amour, E. O. Deere, H. E. Ewing, Wayne Ewing, J. R. Eyer, J. Forrest Garner, Mr. and Mrs. A. A. Heinze, Luther Hoyle, H. G. Hubbard, W. H. Hukriede, A. M. Isbel, Remington Kellogg, Mrs. W. E. Kiser, George F. Knowlton, Paul B. Lawson, A. W. Lindquist, Mrs. J. M. Mayfield, H. A. Morgan, Albert Milzer, Felix Nolte, C. K. Orrison, Cornelius Philip, N. R. Randle, Burton Risser, Cornelius Rogers, Herbert F. Schwarz, H. C. Severin, Roger Stewart, Myron H. Swenk, Percy Viosca, Ralph Voris, and L. D. Wooster. Records from the literature are as follows: Bogen (1926), Comstock (1913), Crosby and Bishop (1928), Herms (1926), Jellison and Philip (1935), Lawson (1933), and Scheffer (1904). All of these persons are cited by their last names only in connection with the accompanying locality data.

COLORADO (All records by D'Amour unless indicated otherwise): ADAMS (Prairies E. Denver); ARAPAHOE (Daniels Park about 10 mi. s. Denver); DENVER (Denver); JEFFERSON (Indian Hills, Milzer, Sept. 19, 1934); and LARIMER (Estes Park, and Fort Collins, Milzer) counties.

KANSAS: ANDERSON (6 mi. S. Garnett, Burt, April 1, 1934); ATCHISON (Atchison, Nolte); BARBER (Lake City, Rogers, April 1, 1934; and Sun City, Adams, Aug. 15, 1934); BOURBON (Fulton, Orrison, Sept. 20, 1934); CHASE (1 mi. S. Saffordville, Breukelman, Oct. 21, 1934; and also 8 mi. S. Saffordville, Nov. 4, 1934); CHAUTAUQUA (Camp Ta-la-hi 4 mi. S. E. Cedarvale, Hoyle, July 27, 1934); CLARK (Ashland, Mayfield, Aug. 28, 1934); COWLEY (1 mi. E. Cambridge, Burt, Mar. 31, 1934; also 3 mi. S. W. Hooser, Apr. 21, 1934; 5 mi. E. Rock, Apr. 16, 1934; 7 mi. N. Wilmot, Apr. 15, 1934; 1 mi. E. Winfield, Mar. 26, 1934; and 8 mi. S. E. Winfield, Mar. 21, 1934); DICKINSON (3 mi. S. W. Navarre, Breukelman, Jan. 5, 1935); DOUGLAS (Lawrence, Lawson); EDWARDS (Lewis, Hukriede, Aug. 20, 1934); ELK (3 mi. N. W. Grenola, Hoyle, Aug. 15, 1934; and Moline, Garner, Sept. 19, 1934); ELLIS (Hays, Scheffer; and 3 mi. W. Hays, Wooster); FORD (Dodge City, Ackley and Randle, Sept. 9, 1934); GRAHAM (by Wooster); GREENWOOD (Eureka Country Club, Breukelman, May 2, 1934); HARVEY (Sedgwick, Kiser, Sept. 15, 1934); HODGEMAN (Burdett, Wooster; and Jetmore, Atwood, Sept. 3, 1934); KINGMAN (Waterloo, Burt, Nov. 11, 1934); KIOWA (Greensburg, Ewing, July 21, 1934); LABETTE (2 mi. S. W. Dennis, Breukelman, Mar. 30, 1934); LYON (5 mi. N. E. Reading, Breukelman, Oct. 14, 1934; and also, Santa Fe R. R. Yards at Emporia, Oct. 22, 1934); McPHERSON (Lindsborg, Deere); MONTGOMERY (Coffeyville, Risser, Nov. 12, 1934, through Lawson; and 7 mi. E. Independence, Burt, Apr. 1, 1934); MORTON (7 mi. N. Elkhart, Burt, May 27, 1934); PAWNEE (1 mi. S. E. Larned, Burt, Apr. 8, 1934); RENO (2 mi. S. Medora, Burt, Nov. 11, 1934; and 7 mi. S. Sterling, Breukelman, May 6, 1934); RILEY (Manhattan, Scheffer); STEVENS (Hugoton, Stewart, Aug. 20, 1934); SUMNER (at Oxford); THOMAS (Colby, Wooster); and WALLACE (Wallace, Scheffer) counties.

KENTUCKY: HOPKINS (Nebo, Voris, Oct. 25, 1926) county.

LOUISIANA: CONCORDIA (2 mi. S. W. Ferriday, Burt, June 15, 1934, cypress swamp); EAST BATON ROUGE (Baton Rouge, Morgan, June 27, 1897, U. S. N. M.); ORLEANS (New Orleans, Viosca); and SABINE (4 mi. S. W. Many, Burt, June 16, 1934) parishes.

MICHIGAN: CHEBOYGAN (Cheboygan, Hungerford, from Lawson) county.

MISSISSIPPI (All records from U. S. Nat. Mus. specimens): CLARK (by Kellogg, Oct. 21, 1929) and JACKSON (Escatowpa, Colmer, July 24, 1930) counties.

MISSOURI: BATES (10 mi. E. Adrian, Breukelman, Jan. 6, 1935; GREENE (Springfield, Voris); JEFFERSON (Kimmswick, Heinze); LACLEDE (Lebanon, Voris); and ST. LOUIS (St. Louis, Heinze) counties.

MONTANA: RAVALLI (Hamilton, Philip, from Lawson) county.

NEBRASKA: (All reports from Swenk unless indicated otherwise): ADAMS (at Hastings); BOX BUTTE (Alliance); BUFFALO (Kearney); CUSTER (Callaway, and Mason City); DAWES (Chadron, and Crawford, Cook); FURNAS(Arapahoe, Beaver City, and Edison); HOLT (O'Neill); HOWARD (Cotesfield); KEITH (Roscoe); KIMBALL (Kimball); LINCOLN (North Platte); LOGAN (Gandy); LOUP; PHELPS (Holdrege); RED WILLOW (Danbury, Worley and Pickwell; also, McCook); SCOTTS BLUFF (Mitchell, Worley and Pickwell); SHERIDAN (Rushville); and WEBSTER (Red Cloud) counties.

NEW HAMPSHIRE: HILLSBOROUGH (Hollis, Comstock) county.

NEW MEXICO: DONA ANA (State College, Eyer) county.

NEW YORK: QUEENS (Woodhaven, Crosby and Bishop); and NIAGARA (Lewiston, Crosby and Bishop) county.

OKLAHOMA (All records by Burt): CREEK (2 mi. W. Bristow, Apr. 2, 1934; also, 2 mi. E. Sapulpa); KAY

(6 mi. N. E. Newkirk, Mar. 27, 1934); OSAGE(2 mi. N. E. Burbank, Apr. 3, 1934) and SEMINOLE (4 mi. E. Seminole, June 2, 1934) counties.

SOUTH DAKOTA: PENNINGTON (Black Hills, Severin) county.

TEXAS (All records by Burt unless indicated otherwise): BEXAR (San Antonio, Ewing, Mar. 22, 1927, U. S. N. M.); BURLESON (Merle, Isbel, Feb. 10, 1897, U. S. N. M.); DALLAS (9 mi. N. W. Dallas, Cheatum; also, 10 mi. S. E. Seagoville, and 2 mi. N. W, Vickery); ERATH (3 mi. S. W. Dublin, March 17, 1934; also, Dublin); HARDIN (7 mi. S. E. Kountze, July 6, 1934, U. S. N. M.); HARRISON (Caddo Lake, Cheatum); HOOD (2 mi. S. W. Cresson, March 16, 1934; also 1 mi. S. Granbury); PALO PINTO (Mineral Wells, Cheatum); SABINE (5 mi. S. W. Pendleton Ferry, June 17, 1934); SMITH (8 mi. S. E. Tyler, June 17, 1934); TARRANT (2 mi. S. W. Benbrook, Mar. 16, 1934; also, 16 mi. S. W. Fort Worth, Cheatum); TAYLOR (Abilene, Sanders); and UVALDE (Uvalde, Lindquist) county.

UTAH (All records by Knowlton); CACHE (Logan and Providence); DUCHESNE (Myton); SALT LAKE (Holiday, Magna, and Salt Lake City); UTAH (Provo and Santaquin); and WEBER (Ogden) counties.

WASHINGTON: YAKIMA (Yakima Valley, Jellison and Philip) county.

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OBSERVATIONS ON THE SEASONAL ACTIVITIES OF WIREWORMS (ELATERIDAE)*

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Published information regarding the seasonal activities of wireworms is limited to fragmentary reports of casual observations. This lack of information is partly due to the tremendous amount of labor and time which must be expended in order to acquire authentic data regarding the subterranean habits of insects which undergo a part or all of their development in the soil. The problem also is complicated because observations on the activities of the insects living beneath the surface of the soil cannot be made accurately due to the character of the medium in which they live.

Investigators in the field of subterranean insects should understand the conditions of a soil environment because it is a very complex one when considered from its chemical, physical and biological aspects. Insects which make their homes in this environment respond abnormally to it when the intimate relationship which exists between them and the soil is disturbed. That the soil is a suitable habitat is evidenced by the fact that a majority of insects undergo a part or all of their life cycles in the soil.

Since subterranean insects and the soil in which they live are disturbed each time observations are made, and since many wireworms require several years to complete their development, data have been collected over a period of years to insure dependability. While conducting researches on the habits, life histories and methods for the control of wireworms, the writer had an opportunity to collect data regarding their seasonal activities over an eight-year period at Manhattan, Kansas.

These observations and records have been confined for the most part to the activities of three or four species of Melanotus, and one species of the genus Aeolus.

Methods

The methods employed in this investigation included

*Contribution 427 from the Department of Entomology.

**The writer wishes to express his appreciation to Messrs. Fred S. Kruger and Sam G. Kelly for their assistance in accumulating a portion of the data for this manuscript. Further acknowledgement is made to H. C. Manis who made the chart.

field and insectary studies. Data obtained in field investigations were taken from records of wireworm population found in a series of holes which were dug in various habitats at different times throughout the year and from collection records of larvae found at the surface of the soil beneath stones, cow-dung, sorghum heads, and at the roots of cultivated crops.

The manner of collecting the data secured from the holes which were dug has been described in a previous publication—McColloch, Hayes, and Bryson (1928). Such collections were made over a period of eight years, while the data secured from the excavations cover only two years.

The temperatures recorded in this paper were taken by means of a hotbed thermometer inserted into the soil so that the metal end was at a six-inch depth.

Discussion of References

A review of the literature pertaining to the hibernation of wireworms reveals the fact that these larvae are capable of withstanding the temperatures of solidly frozen soil. Observations cited in the literature indicate that the larvae go down into the soil to escape the rigors of winter, even though they possess the ability to survive very low temperatures.

Mail (1930), in a study of winter soil temperatures and their relation to subterranean insect survival, found that "larvae and adults of **Melanotus communis** Say have sufficiently low freezing points to withstand Minnesota winter temperatures if they hibernate below four inches in the ground." He also was of the opinion that a heavy mortality of wireworms might result under adverse winter climatic conditions.

Lane (1931), states that the first, second, and third instar larvae of **Ludius pruinosius** Horn var. **noxious** Hyslop "spend the winter deep enough in the soil to avoid freezing temperatures."

Conradi and Eagerton (1914) found larvae three to three and one-half inches below the surface during the winter of 1913-1914, while Gibson (1916) states that the larvae start a downward movement at the approach of cold weather. Howard (1925) found that wireworms hibernate in cultivated land in Washington and California at a depth of five to eight inches.

Preliminary studies on the hibernation of wireworms

conducted by McColloch, Hayes and Bryson (1927) showed the average depth at which wireworms were found during the months from November to February, inclusive, to vary from 7.17 inches to 10.1 inches. These data were based upon the records of only a few individuals.

Presentation of Data and Discussion

During the investigation, the writer has taken numerous larvae at the field insectary when the soil had to be thawed out before the larvae could be removed. Wireworms taken from such a frozen mass of soil appeared lifeless but resumed activity upon their removal to a heated room. Despite this ability to withstand the environment of solidly frozen soil, they do not remain near the surface throughout the winter.

Table I gives a record of the wireworms taken at this station and the depths at which they were found during the months from November until February, inclusive, for the years indicated.

Table I—Number of Wireworms and Depth in Inches at which they were Collected.

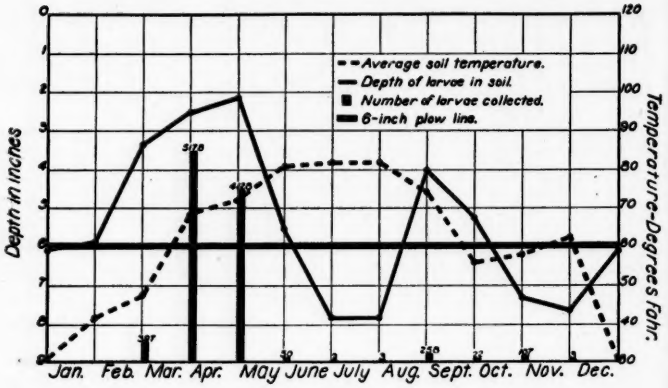
Date	Number Collected	Depth Collected		
		minimum	maximum	average
1922-1923	18	4	16	7.70
1925-1926	74	3	26	10.70
1928-1929	56	1	23	6.00
1932-1933	84	3	14	6.75

The data recorded in Table I for the years 1922-1923 and 1925- 1926 were published in a previous report—McColloch, Hayes, and Bryson (1927).

Horsfall (1929) found 56 wireworms in holes which he dug at this station during a severe winter. The soil was frozen from the latter part of November until the first of March. The data obtained by Hayes (1933) shows a record of 84 wireworms collected during a winter which was so mild that the soil was frozen to a depth of not more than four inches while the excavations were being made.

Chart I is a graphic summary of the number of wireworms taken in collections and excavations each month and the average soil temperatures which prevailed at the time the excavations were made.

Chart No. I—Depth at which Wireworms were taken and the Number Collected for Each Month of the Year.


Depth in Inches
Temperature-Degrees Fahr.
Average soil temperature.
Depth of larvae in soil.
Number of larvae collected.
6-inch plow line.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Examination of the chart reveals two general movements of wireworms downward into the soil. Both of these retreats to the lower depths are coincident with changes in the conditions of the soil environment at the surface.

The downward movement in the summer occurs usually from the latter part of June to the middle of July. Apparently after reaching a suitable depth, the wireworms remain there until after the high temperatures of August and early September. It may be that all of those going down at this time are not making an attempt to escape the unfavorable surface conditions, but to pupate. This is particularly true of some species of the genus Melanotus.

Previous studies conducted at this station by the writer (1928) also show that of 199 adult Melanotus, removed from their pupal cells during the winter, 92 per cent were below the six-inch plow line. Consideration of the fact that these pupal cells were constructed by the larvae in July and August makes it apparent that not all of the larvae found below the plow line during these months are there merely to escape the unfavorable conditions at the surface. Further investigations would be necessary to confirm the theory that unfavorable conditions of the surface environment influence the depth at which the pupal cell is located.

Since smaller, immature larvae are also found at a depth below plowline during the winter, one can be reasonably sure that the majority of the larvae move downward to escape the rigors of winter, when the surface of the soil is not covered with a protective covering of bunch grass, rock or other insulating material. No doubt the depth to which they go varies somewhat from year to year, depending upon the severity of winter temperature.

An examination of the accompanying graph indicates that the wireworms return to the surface of the soil very early in the spring. As the curve indicating the average soil temperature rises, the movement of the larvae is toward the surface. This migration begins toward the latter part of February and continues until the latter part of June, when the temperature of the soil becomes higher.

The collection records in Table II show that a large number of larvae can be collected at Manhattan beneath and at the margins of stones on the south slopes of hills exposed to the direct sunlight. The stones not only furnish protection to the roots of the prairie grass but also absorb the heat from the sun's rays and thus promote early growth in the spring. That suddenly lowered temperatures of the air, and to a less degree of the soil, force the larvae to retreat into the soil is evidenced by the fact that practically no wireworms can be found underneath the stones following a series of cold, cloudy days. No wireworms were found under stones when the soil was dry.

As the season progresses, the number of larvae taken increases until the vegetation has begun to grow, after which time they leave this situation. Table II shows a total of 334 wireworms collected in March under stones, 1073 in April, while none was found in the same location during the other months.

The next habitat in which the larvae were found in numbers was on the native prairie in cow-dung dropped by cattle which had grazed the pasture during the previous season. As many as 30 larvae have been taken in a single dropping. In one area of less than two acres, 1500 larvae were collected in a single day. It is not known exactly why the larvae were attracted to the droppings unless they were predacious upon the grubs of the little dung-beetle, **Aphodius fimetarius** which are so numerous in these situations at this season of the year.

Table II—Number of Wireworms Collected in Various Habitats for the Months indicated during Period from 1925-1933, Inclusive.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Number of Wireworms Taken in Holes											
1928-1929	12	4	34	7	36	30	8	None	15	36	12	28
1932-1933	27	16	30	26	16	13	19	Dug		18	12	28
Habitat	Number of Larvae Collected 1925-1933.											
Old Sudan grass roots			63							20		
Under Stones			334	1073								
In cow manure				4099	78							
Alfalfa roots				6								
Plowed soil					8							
In oats and rye					53							
Volunteer Corn					581	34						
Sheperd's purse					8							
Weed Patch						16						
Sorghum roots							2					
Watered soil								3				
Under sorghum heads									248	2		
Base of corn plants									10			
Rye pasture											107	
Early planted corn					3700							
Total			397	5178	4428	50	2	3	258	22	107	3

The wireworms have been observed feeding upon these grubs and are nearly always associated with them. It is interesting to note that holes two by three feet in area dug in native grasslands rarely reveal the presence of more than an average of one or two wireworms to the square foot while a dense population of the larvae is to be found during April and May in cow-dung. At this time the grass roots have become well started, but it appears that the wireworms have forsaken the vegetative diet for one consisting of dung beetle larvae. They are not found in dry droppings.

The wireworms remain in cow-dung until the dung-beetle grubs pupate. Apparently there is very little tendency toward cannibalism while the larvae are in the cow-dung. The writer has confined 100 or more larvae of the same size in an ordinary pocket tobacco tin for a period of one week, without any noticeable loss through cannibalism.

During the latter part of April, May, June and the first part of July, the larvae are to be found near the surface feeding on germinating seeds and at the roots of various cultivated plants. On the native grasslands they are not found in large numbers at any time. Diggings to locate them reveal a rather even distribution in the grasslands, but a concentration in rowed crops planted on cultivated lands. Corn planted in the middle of April and which has been retarded in its germination by unfavorable soil conditions is particularly subject to attack. It was under such soil conditions that the 3700 wireworms were collected in May, as recorded in Table II.

No holes were dug in the month of August, but the remainder of the curve on the chart as well as the collection record in July indicate that the larvae are down in the soil at that time. This is further verified by the fact that the soil temperatures during August are similar to those in July. The collection records for the two months show conclusively that comparatively few wireworms are to be found near the surface of the soil.

Table III—Depth in inches at which Wireworms were Taken Throughout the years 1928-1929 and 1932-1933.

1928-1929	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.*	Sept.	Oct.	Nov.	Dec.
Maximum	15	6	15	2	12	14	19		18	13	23	25
Minimum	3	2	2	1	1	1	2		1	1	1	1
Average	6.5	4	4	1.5	1.8	2	5		4	5	7.5	7.5
1932-1933												
Maximum	12	14	12	12	6	14	16		*	14	13	12
Minimum	2	3	1	1	1	2	7		*	2	3	5
Average	5.59	7.56	2.73	3.35	2.5	9	10.84		*	5.44	7	7.71
Average	6.04	5.78	3.36	2.47	2.15	5.50	7.92			5.22	7.25	7.60

* no holes dug.

A further examination of Chart I and Table II shows the return of the larvae toward the surface as the soil temperatures begin to descend. The temperature curve which is for the year 1932-1933 declined from 82 degrees in August to 74 degrees in September and continued downward until December. The collections near the surface were greatest during September, but larvae were found at the surface in October, November and December. Those collected in December were found in the roots of Sudan grass.

Table III shows the maximum, minimum and average depths at which wireworms were taken in holes dug for the months during the period of 1928-1929 and 1932-1933.

The chart shows plainly that the larvae are found below the six-inch plow line during the two winter months. A knowledge of this fact has a valuable bearing on recommendations made for their control. If the soil were plowed during October, November, or early December, the soil would not be so cold as to prevent the larvae from going down. If they are plowed out when active, they immediately burrow into the soil and seek the level where the environmental conditions are most suitable to them.

During July, August, and the early part of September when the soil temperature is high and when there is a lack of soil moisture, the wireworms are too deep in the soil to be turned up by the plow.

Such an ecological study suggests the desirability of seeking methods other than plowing as a means of destroying the larvae.

Summary

1. Wireworms move upward and downward in the soil in response to unfavorable environmental conditions at the surface.

2. Extreme soil temperatures, above 80 degrees Fahrenheit or below 32 degrees, apparently are unfavorable to the larvae.

3. Observations and collection data indicate that the larvae can withstand freezing temperatures without apparent injury.

4. Similar observations show that they are injured by high temperatures which dry out the soil.

5. The data show that the larvae are below the plowline

during November, December, and January in the cold season of the year, and during July and August during the summer season.

6. Diggings reveal the fact that the larvae are near the surface or at least above plowline during the other severe months of the year.

7. Collection records show the larvae feeding near the surface on the roots of weeds and various cultivated plants. Food studies indicate a predacious habit.

8. Recommendations to fall plow as a means of control for this pest would be of questionable value.

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LUBRICATING OIL EMULSION AS A BUFFALO GNAT REPELLENT[1]

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Department of Entomology, University of Arkansas.

Buffalo gnats of the species **Eusimulium pecuarum** (Riley) are an annual problem in many localities in the lower Mississippi valley. In Arkansas serious outbreaks have occurred frequently in the valleys of the Sulphur, White, St. Francis, and Arkansas rivers. Farmers in the infested areas protect their livestock chiefly by the use of smudges and repellents.

Because of the high cost and injurious nature of most of the repellents commonly used, an effort has been made to find a material which would be efficient, non-injurious, and moderate in cost. The most promising one so far found is a cold-mixed oil emulsion similar to that described by Richardson and Griffin[2], and made from potash fish-oil soap and lubricating oil, one pound of soap being used to emulsify three quarts of oil. The resulting thick emulsion is diluted with one part of water for use. Oil drained from the crank-cases of cars can be used if it is allowed to stand for two weeks before mixing. This allows the dirt, particles of metal, and other foreign matter to settle out leaving the oil fairly clean.

Tests made during the seasons of 1933, 1934, and 1935, in various gnat infested counties in Arkansas, have shown this emulsion to be equal to or superior to the repellents now in use. In addition it is very low in cost and has not caused noticeable injury to mules and cows, the animals on which tests have been made. Applications remain effective for three to eight hours, depending on weather conditions, and the activity of the animal.

If made from used oil this emulsion can be prepared at a cost of not more than ten cents a gallon. One man can easily mix ten gallons in an hour, using a wooden churn dasher and a lard can. In Arkansas, manufactured gnat repellents sell at an average of one dollar a gallon.

1. Research Paper No. 376, Journal Series, University of Arkansas.

2. Richardson, C. H. and Griffin, E. L.. 1926. Modifications of Methods of Making Cold-Mixed Oil Emulsions, Jour. Econ. Ent., 19: 525-529.

VARIATIONS IN THE SEASONAL HISTORY OF THE COLORADO POTATO BEETLE[1]

DWIGHT ISELY, University of Arkansas.

The Colorado potato beetle is one of our best known insect pests. Because it is easily controlled, its biology has received little attention from economic entomologists but has been studied chiefly by those interested in physiology or genetics. Notwithstanding its familiarity it is difficult to find two statements of its seasonal history which are in agreement. Tower (4) reported that it is definitely two brooded, although he also records the occurrence of a five brooded race. Girault (3) reared at least parts of three generations. Fink (2) states that the species is definitely single brooded. Texts are frequently indefinite, or assume that the number of generations vary to suit the length of the season.

While rearing beetles a number of years ago to secure larval material for laboratory use, a variation in seasonal history came to my attention. An attempt was made to determine if factors other than inheritance govern seasonal history[2]. More pressing problems of insect control did not and probably will not permit giving this problem the constant attention it requires, and hence these incomplete notes are presented.

In Arkansas the potato beetle appears quite definitely to be a one generation species. Most beetles emerge from hibernation in April and deposit eggs from late April to June. Adults of the first brood mature from May until early July and after feeding for a few days bury themselves again to rest until the next spring. The entrance into the diapause occurs in spite of an abundance of food, of favorable weather, and a season ahead long enough to produce several generations. I have been unable to bring beetles out of the diapause prematurely by excessive watering as Brietenbecker (1) reported. The active feeding period of the overwintered adults and of the larvae is during the period when foliage of early potatoes, or of their most important wild host in Arkansas, **Solanum carolinense,** is growing rapidly. This is the usual seasonal history but variations occur. In at least one year,

1. Research Paper No. 377, Journal Series, University of Arkansas.
2. Charles G. Lincoln, formerly student assistant aided in the rearing work.

1924, a belated outbreak of potato beetles occurred in September in Scott County where a commercial acreage of late potatoes was grown.

Under favorable conditions the life cycle has been completed in as brief a period as 31 days; incubation requiring 4 days; the larval feeding period 10 days; the period in the soil including prepupa, pupa and callow adult, 10 days; and the preoviposition period 7 days.

In 1930 a total of 345 beetles of the first generation were reared between May 29 and July 20. These beetles were reared from lots of eggs secured from overwintered adults collected in May. Of this entire number 324 went into hibernation within 10 to 15 days after maturity and remained there until the next spring. No eggs were deposited. The other 21 beetles, which were among the last of the generation to mature and which happened to be divided into three lots, did not go into hibernation but reproduced and died when the reproduction period was ended. All beetles of the succeeding generations were progeny of these three lots. The only essential difference in handling these beetles was that the emergence in the earlier part of the season was fed such foliage of potatoes, **Solanum carolinense,** and tomatoes as could be easily secured. This foliage was relatively mature. At the last of the season the beetles were fed foliage of tomatoes which had been forced into rapid growth by applications of nitrate of soda and by cutting back the plants severely.

Because of the pressure of other work, no special attention was given to beetles of the second generation, except to feed them foliage from heavily nitrated plants. Most of them reproduced and died at the end of the reproduction period. The only records for the preoviposition period was for 9 females reared between August 18 and 24 and ranged from 5 to 10 days, with an average of 8.11 days.

Beetles of the third generation, which emerged between September 25 and October 7, were likewise fed foliage from nitrated plants. Eleven of 13 females kept under observation deposited eggs within from 6 to 9 days after emergence, with an average of 7.38 days.

The beetles of the fourth generation were reared between October 27 and November 11. At that time, rapidly growing foliage was not available for food. Nearly all of the 242 beetles reared went into hibernation after feeding a short time. No eggs were produced.

No positive conclusions can be drawn from these records regarding the relationship, between the availability of rapidly growing foliage for food during the first few days of the adult stage, and the number of generations. These contrasting lots of material were not reared simultaneously and possibly may have represented different strains. The records were highly suggestive, however.

During the succeeding years the majority of the beetles reared were single brooded, but in 1931 part of a second generation was reared, and in 1932 and 1933 there were individuals of a second and third generation. I failed to connect this definitely, however, with food.

A divergence from the usual longevity also developed. A few of the beetles reared each year survived two reproductive seasons and two winters. Of the beetles reared in 1930, 3 females deposited eggs both in 1931 and 1932. One of these beetles went into hibernation in 1932 but did not emerge the third season. Similarly 4 females reared in 1931, reproduced in 1932 and 1933, but failed to emerge in 1934. Of the beetles reared in 1932, 24 females deposited eggs in 1933 and then went into hibernation; one reproduced in 1934.

The duration of the diapause also exhibited an irregularity among the beetles which matured in 1932. Of those which matured that summer 36 failed to resume activity in 1933, but did emerge from the soil and reproduced in 1934.

The diapause was occasionally shorter than a single season. In both 1932 and 1933 beetles were recorded as having emerged from the soil and reproduced after apparently going into hibernation earlier in the year. In 1933 one beetle which matured in June buried itself apparently for hibernation, emerged July 26 and after a brief oviposition period from August 4 to 8 buried itself again. On August 25 it again reappeared, had a second short reproductive period, and by the middle of September again went into hibernation.

Summary

The Colorado potato beetle is quite definitely single brooded in Arkansas, but every year parts of extra generations—sometimes as many as three—occur. These variations are significant, since a crop grown after the normal season of occurrence is not necessarily free from attack. Some of the adults reared each year, from 1930 to 1932, reproduced during each of the two years following maturity, and passed two winters in hibernation.

Some beetles also extended the diapause over two years, maturing in 1932 and reproducing in 1934. This longevity and extended diapause may be of importance in carrying the species through an unfavorable season. Intermittent periods of reproduction and diapause frequently occur during the same season and may extend to the period of attack on its hosts.

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(1) Breitenbecker, J. K.
1918. The relation of water to the behavior of the potato beetle in a desert. Carnegie Inst. Pub. 263, p. 343-384.

(2) Fink, D. E.
1925. Physiological studies on hibernation in the potato beetle***. Biol. Bul. Mar. Biol. Lab. 49: 381-406.

(3) Girault, A. A.
1908. Biological notes on the Colorado potato beetle. Ann. Ent. Soc. Am. 1: 155-178.

(4) Tower, W. L.
1906. An investigation of the evolution in Chrysomelid beetles of the genus Leptinotarsa. Carnegie Inst. Pub. 38:229-257.

NOTE ON THE FOOD OF BIBIO XANTHOPUS* (DIPTERA, BIBIONIDAE)

CURTIS W. SABROSKY, Kansas State College.

Little is known of the feeding habits of adult Bibionidae, although their occurrence in great numbers and their sudden and simultaneous disappearance have frequently been observed and recorded. Their numbers have sometimes caused apprehension, and certain injuries to buds and blossoms of fruit trees, to wheat, and to corn and potatoes have been attributed to these flies. In the cases investigated, however, no injury could be traced to them (e. g., 1, 2), and it was believed that they

*Mr. M. T. James has recently informed the author that the species is probably new, although it does agree fairly well with the description of xanthopus in McAtee's revision of the group.

(1) Kellogg, V. L. 1893. Insect Notes. Kans. Acad. Sci., Trans. 13:112-115.

(2) Wilson, H. F. 1915. Minor insect pests (Abstract). Rev. Appl. Ent. (Ser. A) 3:271-272.

were feeding on the nectar in the blossoms, or merely resting on the foliage. Osborn (3) reported such statements by observers as "eating corn, potatoes, . . . and everything", and "killing the fruit", but he believed that the immense number of flies caused observers to ascribe contemporaneous injuries to them. A different habit was mentioned by Lintner (4), who reported that a gardener believed **Bibio albipennis** to be feeding on the Colorado potato beetle, either on the larvae or on the eggs, a belief which was considered improbable by Lintner. Girault (5) studied the females and oviposition of **Bibio femorata** in some detail, but observed nothing of importance concerning their food habits.

The keen observer, Reaumur, noted that the European **Bibio hortulanus** Meigen did not have mandibles which could gnaw the buds and blossoms as charged. He thought that the fly might injure them, however, by sucking their juices, but Lintner considered this idea to be "doubtless erroneous" (l. c.).

While sweeping for insects in a slough near Manhattan, Kansas, on April 17, 1934, the author collected a large series of a Bibionid, **Bibio xanthopus** Wied., and noted that it was resting in numbers on the vegetation, principally slough grass (**Spartina pectinata**), sedges (**Carex** and **Cyperus** spp.), and dock (**Rumex** sp.).Chance observation of the latter, whose leaves were being eaten by the blue Chrysomelid beetle, **Gastroidea cyanea** Melsh., revealed that numerous Bibionids had their mouthparts appressed against the freshlycut edges of the leaves, apparently sucking the plant juices. Practically all plants of dock in this area were infested with the beetles, and Bibionids were found in this feeding position on all plants examined. This lends support to Reaumur's old belief.

Many pairs in **copula** were also noted at this time. As often reported for these flies, they disappeared rather suddenly, and a few weeks later none could be found by sweeping over the same area.

(3) Osborn, Herbert. 1891. Some notes on Iowa insects. Insect Life 3:479.

(4) Lintner. J. A. 1885. (Notes on the habits of Bibionidae). State Ent. of New York, Second Report, 110-115.

(5) Girault, A. A. 1905. Oviposition of **Bibio femorata** Wied. and ovipositing females. Canad. Ent. 37:322-330.

REDBUD APHIS, Aphis pawneepae Hottes, AN INSECT NEW TO KANSAS.

This newly discovered aphid which attacks the redbud, **Cercis canadensis** L., was described by F. C. Hottes in his paper "Aphid descriptions and notes", Proc. Biol. Soc. Wash. Vol. 47, pp. 3-5, 1934.

The apterous viviparous females have a peculiar colony habit of arranging themselves on the under side of the twigs and branches of the redbud tree, and do not attempt to cover the upper half of the branches. Apparently they do not prefer the new, tender growth, but attack the older wood which is several years of age; namely, the branches of medium size. The smaller aphids are to the side and beneath the larger apterous viviparous females.

Syrphid fly larvae have been found feeding among the smaller aphids. Ants have not been observed on the redbud tree in connection with these aphids.

In 1934, one observation was made of this insect attacking a redbud tree located on the Kansas State College campus. On May 5, 1935, the redbud tree attacked was located three-fourths to one mile southwest of the first location.

Is this insect ordinarily an underground feeder and, due to dry soil conditions, was it forced above ground during 1934 and 1935?

RALPH L. PARKER, Manhattan, Kans.

MINUTES OF THE ELEVENTH ANNUAL MEETING OF THE KANSAS ENTOMOLOGICAL SOCIETY.

University of Kansas, Lawrence, Kansas
March 30, 1935.
Business Meeting

President H. R. Bryson called the meeting to order at 10:10 a. m. in room 417, Snow Hall.

The minutes of the tenth annual meeting were read and approved.

Reports of Officers. The secretary reported the Society as having 100 subscribers to Vol. 8 (the current volume) on March 28, 1935. Subscribers are distributed in England, Canada, Austria, Italy, Germany, Peru and the United States.

The treasurer reported that on March 28, 1935, the

Society had as assets in a time deposit $300.00; in the checking account of the treasury, $213.62; accounts receivable, $86.11, and that all bills against the Society were paid to date. Report approved.

The editor was not present and did not make a report.

Reports of Committees.

Wild Life. W. Knaus reported progress and that he was working in conjunction with the Kansas Academy of Science committee.

Appointment of Committees.

Nominations Committee
H. B. Hungerford, Chairman
P. B. Lawson
L. M. Gates

Resolutions Committee
Dwight Isely, Chairman
Kathleen C. Doering
R. H. Painter

Auditing Committee for 1935-'36
R. H. Beamer, Chairman
H. H. Schwardt

Old Business. The secretary made a report for the combined executive and publication committees that the price of Vol. 8 of the Journal would be $1.50 because of the increased printing costs. The cost of printing has increased 50 per cent and this cost increase began with the last two numbers of Vol. 7. Report approved.

The secretary made a report of the transfer in December, 1934, of all the back volumes (Vol. 1 thru Vol. 7) of the Journal, from the printing plant in McPherson to the library of Kansas State College. President Bryson had made an audit of the back volumes which were placed in storage in the Kansas State College library. This audit is on file with President H. R. Bryson, Editor P. B. Lawson, the publisher, W. Knaus and the secretary. Report approved and that it be placed on file.

At the end of the business meeting six papers were presented to the Society as follows:

1. Growth rate of the cockroach.
   L. C. Woodruff, Univ. of Kans.
2. Regeneration in the cockroach.
   L. C. Woodruff, Univ. of Kans.
3. The genus **Anthracophaga** in North America

(Diptera, Chloropidae).
Curtis W. Sabrosky, K. S. C.

4. A proposed classification of the Nearctic Stratiomyinae (Diptera).
Maurice James, Ft. Collins, Colo.

5. The families of the Fulgoroidea.
Kathleen Doering, Univ. of Kans.

6. The genus Bacillometra. (Hemiptera, Hydrometridae) H. B. Hungerford, Univ. of Kans.

H. B. Hungerford made an announcement that the Department of Entomology would be pleased to have any visitors who cared to, visit the Snow Entomological museum during the noon adjournment following the luncheon.

Maurice James of the Department of Entomology, Colorado State College, made an announcement that the Rocky Mountain Entomological Conference will be held the third week in August at Pingree Park, Colorado. Entomologists and Biologists interested in attending this conference should write to Dr. George M. List, State Entomologist, Ft. Collins, Colorado.

Adjournment for luncheon was at 11:53 a. m. and 1:30 p. m. was the time set for reconvenment.

The Society reconvened at 1:32 p. m. for the presentation of the following papers:

7. The Alconeura of the United States.
Melvin Griffith, Univ. of Kans.

8. **Achalarus lycidas** Abb. & Sm. (Lepidoptera, Hesperidae) New to Kansas.
Wm. D. Field, Univ. of Kans.

9. Notes in regard to the redbud leaf folder, **Gelechia cercerisella** Cham. (Lepidoptera, Gelechiidae).
R. L. Parker, K. S. C.

10. The unspotted tentiform leaf-miner, **Ornix prunivorella** Cham. (Lepidoptera, Tensidae), a pest of the apple tree.
L. M. Copenhafer, K. S. C.

11. Suggestions for revision of Orthopteroid morphology. Philip Levereault, Univ. of Kans.

12. Studies on the taxonomy and external morphology of grasshopper eggs. R. C. Bushland, K. S. C,

13. Some problems in transporting insects to foreign countries.
Sam G. Kelly, K. S. C. (Read by A. L. Robinson)

14. Observations on termites in the Great Plains region. Olive Falls, K. S. C.

15. Motschulsky's types of North American Stenelmis (Coleoptera).
Milton Sanderson, Univ. of Kans.

16. A preliminary report on the study of the Genus Listronotus (Coleoptera, Curculionidae).
Lyman Henderson, Univ. of Kans.

17. Some quantitative effects of the extremes of the summer of 1934 upon the insect population of grasses. D. A. Wilbur, K. S. C.

18. A comparison of the Leipdoptera caught at a light trap, 1933 and 1934.
Don B. Whelan, Univ. of Nebr.

19. Notes on the Biologies of nut weevils.
Otto Kumpe and Dwight Isely, Univ. of Ark.

20. Variations in the seasonal history of the Colorado potato beetle.
Dwight Isely, Univ. of Ark.

21. Possibilities and limitations of forecasting insect occurrence.
Dwight Isely, Univ. of Ark.

22. Lubricating oil emulsion as a buffalo gnat repellent. H. H. Schwardt, Univ. of Ark.

23. Study of the genus Abedus.
Joe Hidalgo, Univ. of Kans.

24. Certain Arthropods of Schofield Barracks, Hawaii. Thompson Lawrence, Univ. of Kans.

Final Business.

Reports of Committees

Resolutions Committee

(1) Be it Resolved: That the Kansas Entomological Society express its appreciation to the officers of the Kansas Academy of Science, to the officials of the University of Kansas, and especially to the Department of Entomology for the excellent facilities provided for its annual meeting.

(2) Be it Further Resolved: That we thank the Editor of the Journal of the Kansas Entomological Society, Dr. P. B. Lawson; the Secretary-Treasurer, Dr. R. L. Parker; and the Publisher, Dr. Warren Knaus, for their faithful and untiring efforts in connection with the publication of the Journal.

(3) Be it Further Resolved: That the Secretary send immediate greetings to Doctor Knaus and express regret that he was absent for the first time since the organization of the Society.

(Signed)

Reginald H. Painter
Kathleen C. Doering
Dwight Isely

Report Adopted.

Auditing Committee

We the Auditing Committee have examined the books of R. L. Parker, Treasurer of the Kansas Entomological Society, and find them correct as reported and in good order.

(Signed)

R. H. Painter, Chairman
Paul B. Lawson

Report Adopted.

Nominations Committee

President—Kathleen C. Doering
Vice-president—D. A. Wilbur
Secretary-Treasurer—R. L. Parker

Moved that the report of the nominations committee be adopted and the secretary be instructed to cast a ballot for the election of these officers. The secretary so cast the necessary ballot, electing the above named officers.

Past President Bryson called Doctor Doering to the chair to preside.

The decision of the time and place of the next annual meeting was left with the Executive Committee.

Motion accepted for adjournment.

Adjournment at 5:33 p. m.

There were 64 members and friends present from Fayetteville, Arkansas; Ft. Collins, Colorado; Lincoln, Nebraska; Kansas City, Missouri; Topeka, Fort Scott, Mankato, Eureka, Ft. Leavenworth, Baxter Springs, Hays, Lindsborg, Kansas City, Lawrence, and Manhattan, Kansas.

At the club house of the Lawrence Country Club in the evening, 60 or more members and friends enjoyed a banquet and program.

R. L. PARKER, Secretary.

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